U.S. ROUTE 4 BRIDGE
U.S. Route 4, spanning the Mascoma River,
1.5 miles east of Enfield
Canaan
Crafton County
New Hampshire

HAER NO. NH-19

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
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Location: US Route 4, spanning the Mascoma River, 1.5 miles east of Enfield, Canaan, Grafton County, New Hampshire

Quad: Mascoma, New Hampshire
UTM: 19. 732800. 4836200

Date of Construction: 1940

Engineer: John W. Childs, New Hampshire Highway Department

Present Owner: New Hampshire Department of Transportation, Concord, New Hampshire

Present Use: Roadway and pedestrian bridge

Significance: The U.S. Route 4 Bridge, designed by the State Highway Department, is one of approximately fifteen single span high Pratt truss bridges extant in New Hampshire. A late example of a Pratt truss, the bridge is significant for its length of 165', its 90 degree angle of crossing and its former steel open grid walkways (now filled and paved). The bridge was constructed in 1940 during the realignment and straightening of Route 4, the state's principal east-west trunk line between Concord and the Connecticut River Valley.

Project Information: This documentation was undertaken in 1992, in accordance with the Memorandum of Agreement among the Advisory Council on Historic Preservation, the New Hampshire State Historic Preservation officer and the Federal Highway Administration as a mitigative measure prior to the replacement of the bridge in 1993.

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1. Historical Background of the Crossing

The Blackwater Road Bridge is located in the town of Canaan, Grafton County, New Hampshire. Grafton County is situated in the Connecticut River Valley, along the eastern banks of the Connecticut River. The northernmost part of the county is associated with the White Mountains, the easternmost with the Lakes Region and Upper Merrimack Valley. The region is significant in the development of the state of New Hampshire from the days of its earliest settlement, including the establishment of Dartmouth College in the town of Hanover east of Canaan and 19th and 20th century tourism.

The town of Canaan is situated in the southwestern section of the county. It is bounded on the north by Dorchester, east by Orange, south by Enfield and west by Hanover. The surface of the land, while not mountainous, is uneven with significant hills and valleys determining the topography and settlement of the town. The hills are Sawyer Hill, Town Hill and Pinnacle Hill. The four large bodies of water are Canaan Street Lake, Goose Pond, Clark Pond and Bear Pond. The town center is located on the western shore of Canaan Street Lake, on a road that was laid out in 1788, "Canaan Broad Street," and later became part of the Grafton Turnpike (Child 1886:8). The only stream of importance in Canaan is the Mascoma River, which has its source in the northwestern part of the town of Dorchester. The Mascoma runs a serpentine course of approximately fifty miles, emptying into the Connecticut River at Lebanon, passing through Mascoma Lake in Enfield (Child 1886:20). Mascoma Lake is four miles in length and a mile in width. In its course, the river has a fall of more than six hundred feet; it waters a territory of 100,000 acres. The water power available on the stream, upstream from Mascoma Lake, created a climate for early industrial development.

The region was explored as early as 1754 and became immediately desirable for settlement due to the fertile intervale land on the Connecticut River. At the close of the French and Indian Wars, with the threat of Indian attack eliminated, provincial governor Benning Wentworth granted several townships with the objective of settling the land in this region. The town of Canaan was chartered July 9, 1761, on the same date as twenty-two other townships. Most of the proprietors in Canaan came from Norwich or Colchester, Connecticut, beginning about 1766. Four village centers or hamlets developed: East Canaan, Canaan, Factory Village and West Canaan, also known as Mascoma. The first settlers were drawn by "rich intervales, large trees, and abundance of game to be found in the wilderness of Canaan" (Child 1886:221).

The earliest settlement in Canaan was along the road that crossed the Mascoma River near the site of the Blackwater Bridge. The Blackwater Bridge provided a direct link in the local road system between the towns of Canaan, Enfield, Lebanon and Hanover to the west, and the town center of East Canaan and the town of Grafton beyond. More specifically, it linked the early settlement center of West Canaan with the town center of Enfield, 1.5 miles to the southwest. By 1776 there were twenty-four settlers with their families in Canaan, mainly located on a ridge of land called "South Road," extending from the Mascoma River to the Grafton line. South Road, also called Post Road and County Road, was laid out by the county court about 1774 and was a continuation of the post road from Boston to the Upper Coos country. The route is largely in place today; it crosses over the Mascoma

River at the Canaan-Enfield line, following the path of Blackwater Road to West Canaan Village, where it curves south and follows a path parallel with the town line. In 1773 the town also voted to lay out a road from the road that led from "the Lower Great Meadows across Town Hill to ye mills on ye north bank of Masquomy through Mr. John Scofield's intervale lot to Ezekial Wells' intervale lot" (Child 1886). The work was not finished in 1778 when the town appointed a committee to complete the bridge over the Mascoma on the Post Road. By 1810, the bridge was referred to as the Old Scofield Bridge.

The specifics of the construction of the bridge prior to the current Blackwater Bridge are not known. The only record surviving is that it was a wooden covered bridge. This is documented in a historic photograph at the Division of Historic Resources, which shows a small portion of the roof of the bridge floating in the river after it was abandoned. Knowing that it was a wooden covered bridge, one interesting possibility exists. An immediate abutter to the bridge was Asa Paddleford, the uncle of Peter Paddleford, well known as the inventor and builder of the Paddleford Truss (Moore 1993). [

The Fourth New Hampshire Turnpike, chartered in 1800, ran from the west bank of the Merrimack River in Boscawen to Lebanon near the mouth of White River at the Connecticut River, with a branch running northwesterly to Hanover. The turnpike largely followed the path of today's Route 4 from Boscawen to Andover and then Route 4A to the northern tip of Mascomy Lake and Lebanon village. County Road met with the Fourth New Hampshire Turnpike in Lebanon village (Walling 1860).

By 1855, the road that largely follows path of today's Route 4 was laid out parallel to and north of County Road, connecting East and West Canaan villages. The two well-travelled roads intersected at West Canaan Village (Eaton 1855), where a growing amount of industry and building developed along Route 4 between the bridge and Mascomy Lake. By 1892, West Canaan village contained ten houses, a blacksmith shop and a railroad depot. South of the bridge, the village of Enfield was densely settled with numerous houses, a wool mill and another mill (Hurd 1892).

The Northern Railroad came to Canaan in 1857, linking Concord to White River Junction in Vermont. The railroad bridged the Mascoma River above Scofield's or Blackwater Bridge. The town history records that the construction of the railroad bridge so changed the current of the stream that it undermined the foundations of Scofield Bridge, and William W. George was appointed agent of the town to settle with the railroad. Stone abutments were installed on the north side of Scofield Bridge to prevent the wearing of the water against the roadway (Wallace 1910:401). The railroad, later owned by the Boston & Maine, had a depot in West Canaan (Child 1886:21). The route of the railroad connected the major trunk line arteries in the Connecticut and Merrimack River Valleys.

The railroad proved to be such an effective mechanism for transporting goods and people that the transportation network of roads was allowed to decline. At the turn of this century, one of the prerequisites for bettering the state's economy and encouraging tourists to visit the state was the creation of better roads. A grass roots citizens' movement formed a campaign for "Good Roads." In 1905, the State Aid

Road Law was passed, as well as a system for registering motor vehicles. The new laws created the post of State Highway Engineer, called for a general highway survey of the entire state, and designated certain roads as state highways. The first engineer was John W. Storrs of Concord, who proposed a system of three trunk line state highways to run from the Massachusetts border in the Piscataqua, Merrimack and Connecticut river valleys to converge in the White Mountains. The system provided access to both the mountains and arteries of commerce between the major towns and cities in the southern part of the state (Garvin and Garvin 1988:188).

The realignment of Route 4 in Canaan from its Blackwater Road path was part of the state-wide effort to modernize the state's highway system. U.S. Route 4 served as the principal east-west trunk line between the seacoast, Concord and White River Junction in Vermont. The Canaan project bypassed about one mile of Blackwater Road and two dangerous grade railroad crossings (Nineteenth Annual Report 1942:9). In August 1940, six men were killed in a truck and train accident at the railroad crossing on Blackwater Road, underscoring the need for greater safety measures on the heavily travelled road between Canaan and Enfield center (Manchester Union August 3, 1940). A public hearing on changes to the highway's route had been held the month before, at the town residents' request (Canaan Reporter June 28, 1940).

2. Technological Design Context and Physical Description

The U.S. Route 4 bridge in Canaan is a single span steel high Pratt truss with riveted connections, bearing upon reinforced concrete abutments. The two-lane structure, aligned on a northeast-southwest axis with a 90 degree angle of crossing, is 164 feet long with an overall width of 31 feet. The roadway width is edged by 2′6″ open steel grid sidewalks.

Each truss consists of seven 22′6″ wide panels of vertical and diagonal members of different sizes. The bridge is constructed with rolled steel channels, angles and plates, all connected with rivets. The top chords and inclined end posts are fastened with top plates and crossed battens. The bottom chord is fastened by a series of riveted rectangular stay plates and is spliced near the second, third, fourth and fifth vertical posts. Halved lengthwise, the Pratt truss is symmetrical, with six verticals and six diagonals, two crossed at the center panel. The structural I-beams are fastened to rectangular gussets, riveted to the inside of the top and bottom chord channels.

The bottom lateral bracing is provided by seven pairs of steel x-members, connected with riveted square gussets at the center and to the lower chords. The top lateral bracing consists of six steel I-beam struts in line with the vertical truss members and five pairs of steel x-members. The x-members in the second and fourth panels are further reinforced with cross members connecting with the I-beam struts and the center square gussets. Two triangles comprise the portal bracing at each end of the top lateral bracing. Sway bracing and struts are provided at each vertical post.

The floor support system consists of eight principal steel I-beams, riveted to the

bottom cbord and vertical and diagonal members. The bridge deck is a 6˝ reinforced concrete flat slab, resting on nine stringers laid transversely. Deteriorated patcbes of concrete in the deck were repaired in the late 1980's by the state Department of Transportation. Wood board shoring was placed under the second and third stringers on eacb side of the bridge (NHDOT Bridge and Road Maintenance files).

The wearing surface is now asphalt, altbougb the earlier surface was concrete. As built, the 26′ wide roadway was edged with 2′4½˝ wide, 5˝ tall open steel grid bridge floor for drainage, and 2′6˝ open steel grid sidewalks, raised 9 3/16˝ off the roadway. Since 1991, the state Department of Transportation filled the open grid floor and paved the roadway from curb to curb. The grid bridge floor is supported by short I-beams resting on the outer deck stringers and floor beams and riveted on the opposite end to two-part vertical rail posts. These posts rest on the bottom chord and tie it to the sidewalk supports and the steel guard rails.

The reinforced concrete abutments rest on steel piles, supported by a sand base with stone rip-raps. The abutments have reinforced concrete caps and butterfly type wings. The truss's bottom chord is 20 feet above tbe average water level of the Mascoma River. The expansion plate is located at the west end of the bridge. The steel bearings, resting directly on tbe abutments, are 1′6˝ high to tbe pins, bolted with 1½˝ bolts.

3. Construction and Evolution of the Existing Bridge

Construction of the U.S. Route 4 bridge in 1940 was one part of a highway project that bypassed about one mile of the old route, now known as Blackwater Road, and the two dangerous railroad crossings at grade on that road. Plans for the bypass were already underway in July 1940 when six men were killed instantly when their truck collided with a train at one of those crossings. The east end of the bypass was about 40 feet west of the West Canaan Church; the route ran parallel with the railroad for about one mile over the Enfield town line. The new highway required the construction of two bridges: the U.S. Route 4 Bridge over the Mascoma River and a 78 foot long reinforced concrete slab bridge over Crystal Lake Brook at the east end of the bypass (still standing) (Canaan Reporter September 27, 1940).

R.G. Watkins & Son of Amesbury, Massachusetts, was awarded the contract to construct the bighway and two bridges; the firm's bid was the lowest at $73,889.49 (Canaan Reporter September 27, 1940). Watkins subcontracted part of the project; Frederick W. Bryan of Dedham, Massachusetts, is listed as the bridge contractor in state Department of Transportation records (Sverdrup 1982). American Bridge Company fabricated the steel truss in its Elmira, New York, plant (Sverdrup 1982). The American Bridge Company was founded in 1900 by industrial baron J.P. Morgan; the company quickly purchased about 30 independent bridge building entities, abruptly ending the era of small diverse, competitive companies. American Bridge was acquired by United States Steel Corporation in 1901 (Darnall 1984:85).

In accordance with well-established state procedures, the U.S. Route 4 bridge was

designed by engineers at the state Highway Department (Cooper 1992). Under the direction of state highway engineer John W. Childs, Sheldon T. Hare designed the bridge, probably under the supervision of Harold E. Langley, assistant bridge engineer (Sverdrup 1982). Significant for its ninety degree angle of crossing and open grid walkways, the design is a late example of the use of a Pratt truss (Sverdrup 1982).

The project began in September 1940, and all rough grading for the highway was completed before cold weather halted operations. The new 100 foot wide roadway was raised in some places eight feet above the level of surrounding land with 76,000 cubic yards of fill (Canaan Reporter September 27, 1940). The bridges and new highway were opened to traffic by the summer (Canaan Reporter September 27, 1940).

Repairs to the bridge have mainly involved cleaning, sandblasting and repainting, as well as accident damage repair (NHDOT Bridge and Road Maintenance files). In 1986, the bridge was "red listed" due to heavy leaking and spalling on the concrete deck and repairs needed to the expansion plate, rockers, truss, and abutments (NHDOT Bridge and Road Maintenance files). In 1987, additional shoring under the deck was installed to keep the bridge in service, and in 1988 repairs were made to deteriorated reinforced concrete in the deck (NHDOT Bridge and Road Maintenance files). In recent years, over-height vehicles on the bridge have been a continual problem. In 1989, a logging truck damaged the top lateral bracing. Damaged steel members were replaced and repainted. Similar damage and repair occurred in 1992 (NHDOT Bridge and Road Maintenance files). As noted above, the roadway recently has been repaved from curb to curb, covering the 2'4 1/2" wide open steel grid floor at each edge of the roadway.

4. Design and Technology

Modern steel truss bridge construction is a descendent of medieval wooden bridge design with king or queen post support systems. In this country, in the early 19th century, bridge builder Theodore Burr of Pennsylvania combined several king post trusses with a wooden arch, creating a new type of stronger bridge (Comp 1977:2). Advances in wood bridge truss design followed, including the Town lattice truss in 1820 and William Howe's use of both wood and wrought iron for additional tension and compression strength in 1840 (Comp 1977:2). Patents for many types of metal and/or wood truss bridges were granted throughout the 19th century, with two types emerging as the most popular by the turn of the 20th century, the Warren and Pratt trusses.

The Pratt truss was patented by Thomas and Caleb Pratt in 1844, designed with thin, light vertical members acting in compression and heavier diagonals acting in tension (Comp 1977:3). Variations on the Pratt design include a Pratt Half-Hip, with inclined end posts that do not horizontally extend the length of a full panel; the Parker and Camelback, Pratts with polygonal top chords; the Lenticular, in which both the top and bottom chords are polygonal and form a lens shape, and the Baltimore, a Pratt with either sub-struts or ties specifically designed to carry heavy loads such as trains (Comp 1977:6).

The metal truss bridge was by far the most common bridge built in this country between 1850 and 1925. Later improvements included the use of riveted rather than pinned connections and the replacement of wrought iron with steel as a stronger structural material after the introduction of rolled steel for widespread use in 1884. In the 1920's and 1930's, reinforced concrete bridges largely replaced truss designs, due to concrete's reduced maintenance costs, greater availability of materials, and aesthetic appeal. Steel and concrete girder bridges became the most common type of bridge built in the United States after World War II witb the growth of the interstate bighway system (Jackson 1988:38).

The bridge was designed by the New Hampshire Higbway Department under the direction of John W. Childs, state bridge engineer. The design was by Sheldon T. Hare, probably under the supervision of Harold E. Langley, assistant bridge engineer. John W. Childs graduated from Dartmouth College in 1909 and began working with the Highway Department in 1916. In 1922 he was appointed division engineer in Littleton and in 1925 state bridge engineer (Concord Monitor September 24, 1942). In that position, he designed and built hundreds of steel, concrete and stone bridges throughout the state and oversaw the construction of all but two New Hampshire bridges between 1925 and 1942 (Concord Monitor September 24, 1942).

There are approximately fifteen single span high Pratt trusses in New Hampshire; in 1987 the group was reviewed in regard to historicity, technological significance and environmental quality by staff from the state Department of Transportation, Division of Historic Resources and Federal Highway Administration. The Canaan bridge was built at the end of the "mature flourishing pbase" of Pratt truss development in the state and was considered in substantially original condition. Thirteen of the state's fifteen single span high Pratt trusses were designed by the state Highway Department; two others were designed before 1900 by John W. Storrs, wbo later served as state highway engineer. The 165 foot long Canaan bridge was one of seven with a noteworthy length of more than 150 feet. The bridge was one of two noted for unusual or novel architectural and/or engineering details. The bridge is built on a 90 degree angle of crossing and formerly had 2'6" wide steel open grid walkways at each side of the roadway (Sverdrup 1982).

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Site Plan